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BRAKE DRUM FOR WET-TYPE BAND BRAKE DRUM AND METHOD FOR MANUFACTURING THE SAME

This application claims the benefit of Japanese Patent applications No. 2002-237209 and No. 2003-002447 which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a brake drum for a wet-type band brake which is used in an automatic transmission, and a method for manufacturing the same.

Related Background Art

An automatic transmission for a vehicle often employs a wet-type band brake in order to control gear shift elements. A wet-type band brake usually includes a brake band which is made of a single steel plate annularly formed with a frictional member bonded onto the inner peripheral surface thereof. The diameter of this brake band is contracted by an actuator so as to fasten a brake drum disposed inside.

The brake drum for a wet-type band brake comprises an outer cylinder with a slide contact surface which is in a slide contact with the frictional member of the brake band and an inner

cylinder serving as a bearing portion. The wet-type band brake is generally used for gear shift control and is usually required to have a sufficient braking performance. For this reason, in order to enhance the braking power at an initial stage of the frictional engagement, such a brake band is conventionally present which is provided with small grooves (annular grooves or helical grooves) substantially along the circumferential direction of the slide contact surface of the brake drum so as to increase a coefficient of friction thereof (see, e.g., Japanese Patent Application Laid-Open No. 8-177903 (official gazette, p. 4, Fig. 2), and Japanese Patent Application Laid-Open No. 2000-238647 (official gazette, p. 2, Fig. 1)).

In a wet-type band brake of this type is, as shown in Fig. 11, for example, grooves 5 are formed at a comparatively large pitch on a slide contact surface 2 of a brake drum by cutting work. For this reason, a land 7 between each adjacent grooves 5 and 5 was not mechined and has a cross section in a linear form. Then, an edge 9 is formed in a border between the groove 5 and the land 7.

However, if the axial dimension of the land 7 is large, an oil film is interposed between the land 7 and the brake band so that a coefficient of friction at the initial stage of the frictional

engagement can not be increased to a predetermined value. Particularly, since the viscosity of the transmission oil is increased at a cooling time, or the like, the oil film is hardly broken when the brake band comes into slide contact, thereby lowering the coefficient of friction. As a result, there arises a problem that the gear shift control in the automatic transmission is difficult to be conducted ideally. Note that the edge 9 which is formed in the border between the groove 5 and the land 7 may damage a little the frictional member of the brake band which is formed of a comparatively soft material at the time of frictional engagement.

In order to prevent the coefficient of friction from lowering at the initial stage of frictional engagement, it is required to reduce the axial dimension of the land 7 in order to reduce the oil film which is interposed between the land 7 and the brake band. Thus, it is examined to reduce the pitch between the grooves 5 and 5.

However, when the pitch between the groves 5 and 5 is reduced to be smaller than the width of the tip end portion of a machining tool (for example, a cutting tool) to eliminate the land, as shown in Fig. 12, the edge 9 formed between the grooves 5 and 5 becomes very sharp, thereby disadvantageously damaging the frictional member of the brake band to

the extent which can not bear comparison with that with the land 7 shown in Fig. 11. The present inventors, et al., have examined to remove the edge 9 by grinding. However, this method would result in an increased number of machining or processing steps and a higher machining or processing cost, so as to deteriorate the mass productivity. As a result, it is difficult to employ this method practically.

SUMMARY OF THE INVENTION

The present invention has been contrived taking the above-described circumstances into consideration, and an object of the present invention is to provide a brake drum in which an oil film is difficult to be interposed on a slide contact surface of the brake drum with a brake band and a frictional member of the brake band is not damaged, as well as a method for manufacturing such a brake drum.

In order to solve the above problems, according to the present invention, there is provided a brake drum for a wet-type band brake having a large number of grooves substantially along the circumferential direction on a slide contact surface with the brake band, wherein each adjacent grooves are smoothly linked or connected to each other through a substantially convex arcuate cross sectional-portion.

According to a preferable feature of the

present invention, a brake drum for a wet-type band brake having a large number of grooves substantially along the circumferential direction on a slide contact surface with the brake band, may be formed with a land between each adjacent grooves and the land and the grooves may be smoothly linked to each other through a substantially convex arcuate cross sectional-portion.

In a rotatory drum for a wet-type brake band of the present invention, the grooves may be formed by cutting work while the substantially convex arcuate cross sectional-portion may be formed by rolling process.

In a brake drum for a wet-type band brake of the present invention, the grooves and the substantially convex arcuate cross sectional-portion are both formed by rolling process.

In a brake drum for a wet-type band brake of the present invention, the grooves may be formed at a pitch of 0. 05mm to 0. 3mm in a dimensional range of 0. 5μm to 50μm in depth and of 0. 05mm to 0. 3mm in width.

According to the present invention, there is provided a method for manufacturing a brake drum for a wet-type band brake having a large number of grooves substantially along the circumferential direction on a slide contact surface of the drum with

the brake band, comprising the steps of: forming the grooves by cutting work; and forming a border portion between each adjacent grooves in a substantially convex arcuate cross section by plastic working using a forming roller.

A method of the present invention for manufacturing a brake drum for a wet-type band brake having a large number of grooves substantially along the circumferential direction on a slide contact surface with the brake band, may comprise the steps of: forming the grooves by cutting work; and forming a border portion between a land existing between each adjacent grooves and the grooves in a substantially convex arcuate cross section by plastic working using a forming roller.

A method of the present invention for manufacturing a brake drum for a wet-type band brake having a large number of grooves substantially along the circumferential direction on a slide contact surface with the brake band, may comprise the steps of: forming the grooves and, at the same time, forming a border portion between each adjacent grooves in a substantially convex arcuate cross section by plastic working using a forming roller.

A method of the present invention for manufacturing a brake drum for a wet-type band brake having a large number of grooves substantially along

the circumferential direction on a slide contact surface with the brake band, may comprise the steps of: forming the grooves and, at the same time, forming a border portion between a land existing between each adjacent grooves and the grooves in substantially convex arcuate cross sectional-portion by plastic working using a forming roller.

In a method of the present invention for manufacturing a brake drum for a wet-type band brake, the grooves may be formed at a pitch of 0. 05mm to 0. 3mm in a dimensional range of 0. 5μm to 50μm in depth and of 0. 05mm to 0. 3mm in width.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a brake drum according to an embodiment of the present invention.

Fig. 2 is a longitudinal cross-sectional view for showing the essential portion of the brake drum according to the embodiment in an enlarged manner.

Fig. 3 is a view for showing a condition that a slide contact surface of the brake drum is subjected to a cutting work in the first embodiment.

Fig. 4 is a longitudinal cross-sectional view for showing a condition of the slide contact surface which has been subjected to the cutting work in a first embodiment, in an enlarged manner.

Fig. 5. is a view for showing a condition that

the slide contact surface of the brake drum is subjected to a rolling process in the first embodiment.

Fig. 6 is a longitudinal cross-sectional view of the essential portion for showing a condition of the rolling process in the first embodiment, in an enlarged manner.

Fig. 7 is a longitudinal cross-sectional view of the essential portion for showing a slide contact surface which has been subjected to the rolling process in the first embodiment, in an enlarged manner.

Fig. 8 is a view for showing a condition that the slide contact surface of the brake drum is subjected to the rolling process in the second embodiment.

Fig. 9 is a view taken along the arrow A in Fig. 8.

Fig. 10 is a longitudinal cross-sectional view of the essential portion for showing a state of the rolling process in the second embodiment, in an enlarged manner.

Fig. 11 is a longitudinal cross-sectional view of the essential portion for showing a slide contact surface of a conventional brake drum, in an enlarged manner.

Fig. 12 is a longitudinal cross-sectional view

of the essential portion for showing another slide contact surface of the conventional brake, in an enlarged manner.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will be described with reference to the drawings.

Fig. 1 is a perspective view for showing a brake drum of an embodiment of the present invention. The brake drum 1 of the present embodiment comprises an outer cylinder 3 with the outer periphery formed as a slide contact surface 2 and an inner cylinder 4 which is provided with a bearing surface. Note that a spline 8 is provided on the inner periphery of the outer cylinder 3. However, in Fig. 1, the spline 8 is indicated by a double dotted line for simplifying the drawing.

A first embodiment of the present invention will be described below.

In case of the first embodiment, as shown in Fig. 2, small grooves 5 are formed on the slide contact surface 2. These grooves 5 are provided along a direction which is substantially the same as the direction of rotation of the brake drum 1. The grooves 5 and 5 are smoothly linked or connected to each other through a substantially convex arcuate cross sectional-portion 6 whose cross section is a

smooth an arcuate surface having a smooth cross section or which is composed of a smooth arcuate surface and a very small flat surface (hereinafter simply called the arcuate cross-sectional portion). The grooves 5 are formed at a pitch of 0. 05mm to 0. 3mm, and in a dimensional range of 0. 5μm to 50μm in depth and of 0. 05mm to 0. 3mm in width.

With the above configuration, a portion remaining between the grooves 5 and 5 is very scarce, so that there is no room for interposing an oil film. As a result, it is possible to prevent a coefficient of friction at an initial stage of frictional engagement from lowering. The arcuate cross-sectional portion 6 is, as described above, comprise a cross section having a smooth arcuate surface or having a smooth arcuate surface and a very small flat surface, so that a frictional member of the brake band which is in slide contact with this arcuate cross-sectional portion would not be damaged. Further, since the size of each of the grooves 5 is small, the number of the grooves 5 to be provided or the density of the grooves 5 can be increased so that the contact surface pressure when the band brake is fastened can be lowered. The grooves 5 may be a plurality of separate annular grooves or one continuous helical groove.

A procedure for machining the brake drum 1 to

form groove in the first embodiment will be described below with reference to Figs. 3 to 7. In case of the present embodiment, a worker at first conducts a cutting work on an outer periphery or on slide contact surface 2 of a brake drum 1 formed by die casting. As shown in Fig. 3, the cutting work is conducted by contacting and pressing a cutting tool 11 which is fixed to a holder 12 onto the slide contact surface 2 of the brake drum 1 while rotating the brake drum 1. A manner of catching the brake drum 1 is the same as that in the case of rolling process using a forming roller which is described later.

Upon completion of the cutting work, a cross section of the groove 5 becomes as shown in Fig. 4. That is, an edge 9 is formed between the grooves 5 and 5. Note that, when a large number of annular grooves 5 are to be formed, the cutting tool 11 is taken away from the brake drum 1 whenever the work or machining of one groove is completed to be moved in the axial direction by a predetermined distance so as to contact and press the cutting tool 11 upon the brake drum 1 for the second time, repeatedly. On the other hand, when the groove 5 is to be formed in a helical shape, the cutting tool is moved in the axial direction at a predetermined moving speed while it is being urged on the brake drum 1.

Next, the worker conducts a rolling process by a forming roller 22 on the edge 9 between the grooves 5 and 5 which are formed by the cutting work so as to plastically deform the edge 9, thereby obtaining the arcuate cross-sectional portion 6. Fig. 5 is a side view for showing a state in which the forming roller 22 is pressed on the outer peripheral surface 2 of the brake drum 1. The inner peripheral surface of the inner cylinder 4 is caught by a first chuck 31 and the inner peripheral surface of the outer cylinder 3 is held by a second chuck 35. Since the inner peripheral surface of the inner cylinder 4 is a bearing surface which has been processed with high precision, it is possible to conduct centering at the processing or machining work with high precision by catching this surface. The inner peripheral surface of the outer cylinder 3 is held by the second chuck 35 which is composed of a large number of segments, thereby preventing elastic deformation by the pressing of the forming roller 22. Note that the holding by the second chuck 35 is conducted for convex portions of the spline 8 formed at the inner periphery of the outer cylinder 3.

The worker conducts, while rotating the brake drum 1 in this state, a rolling process by pressing the forming roller 22 onto the slide contact surface 2 of the brake drum 1, so that the forming roller may

be rotated thereby. A roller holder 23 which is integrally formed with the shaft of the forming roller 22 is elastically supported by a spring 24, and the forming roller 22 is brought into pressure contact with the counterpart member by the elasticity of the spring 2. As a result, an unnecessarily large pressing load is not applied on the brake drum 1.

Fig. 6 is a longitudinal cross-sectional view for showing a process in which the edge 9 is plastically deformed by the rolling process with the forming roller 22. The edge 9 is plastically deformed by pressing the forming roller 22 onto the slide surface 2 of the drum 1 to follow rotation thereof. The deformed edge 9 becomes the arcuate cross-sectional portion 6, as shown in Fig. 2. Or, when the pressing load of the forming roller 22 is large, a land 7 is formed between the grooves 5 and 5, as shown in Fig. 7, and the land 7 and the grooves 5 are linked or connected together smoothly by the arcuate cross-sectional portion 6.

A second embodiment of the present invention will be described below with reference to Figs. 8 to 10.

In case of the second embodiment, the grooves 5 of the brake drum 1 are formed by a rolling process with the forming roller 22, and at the same time, the arcuate cross-sectional portion 6 is also formed.

That is, as shown in Fig. 8 and Fig. 9 (a view taken along the arrow A in Fig. 8), the worker rotates the brake drum 1 in a state that the forming roller 22 having a processing flange 25 is being pressed upon the slide contact surface 2 of the drum 1 with a predetermined pressure, and pressing the forming roller 22 onto the slide contact surface 2 so that the forming roller 22 may rotate following rotation of the drum 1, thereby conducting the rolling process on the grooves 5 and the arcuate cross-sectional portion 6 at the same time, as shown in Fig. 10. In this manner, the cutting work described in the first embodiment is no longer required, and the number of machining steps and the time required for the process can be both reduced.

In the second embodiment, an only work to be conducted for the slide contact surface 2 of the brake drum 1 is the rolling process (plastic processing), so that cut powder is not produced in the least and, at the same time, the yield can be enhanced. In the second embodiment, it is arranged such that only the arcuate cross-sectional portion 6 is formed between the grooves 5 and 5. However, it is possible to form the land by enlarging the pitch of the grooves 5. Also, the groove 5 in the second embodiment may be formed annular, or may be helical, and a method for driving the forming roller 22 in

this case is the same as that for driving the cutting tool in the first embodiment.

The present invention is effected by the above-described embodiment. Thus, it is possible to obtain a brake drum in which an oil film is difficult to be formed on the slide contact surface, a fluctuation in torque at engagement of the slide contact surface with a frictional member can be reduced, and the frictional member as a counterpart member is not damaged. It is also possible to form small-size grooves on the surface of a brake drum though under the restrictions of working or machining tools, thereby forming the brake drum of the present invention described above.